

Determination of Failure Intersections from Constant Life Diagrams

General fatigue: Determine the intersection of *load line* with either *Goodman line* OR *yield line*, whichever gives smaller strength.

Load line: $\frac{\sigma_a}{\sigma_m} = C \quad (= \text{constant})$

Yield line: $\sigma_a + \sigma_m = \frac{S_y}{SF}$

Goodman line: $\frac{\sigma_a}{S_n} + \frac{\sigma_m}{S_u} = \frac{1}{SF}$

Combine load line equation with either yield line or Goodman line equation and solve for σ_a OR σ_m .

Nominal Mean Stress Approach for Preloaded Bolt: determine the intersection of *load line* with *Goodman line*.

Load line: $\sigma_a = K_f(\sigma_m - \sigma_i)$

Goodman line: $\frac{\sigma_a}{S_n} + \frac{\sigma_m}{S_u} = 1$

Intersection: $\sigma_m = \frac{K_f \sigma_i + S_n}{\frac{S_n}{S_u} + K_f}$

Safety Factor: $SF_a = \frac{\sigma_{a,limit}}{\sigma_{a,actual}}, \quad SF_m = \frac{\sigma_{m,limit}}{\sigma_{m,actual}}, \quad SF = \sqrt{SF_a^2 + SF_m^2}$

Residual Stress Approach for Preloaded Bolt: determine the intersection of *yield line* with *Goodman line*. Use alternating stress to determine final answer.

Yield line: $\sigma_a + \sigma_m = S_y$

Goodman line: $\frac{\sigma_a}{S_n} + \frac{\sigma_m}{S_u} = 1$

Intersection: $\sigma_a = \frac{S_n(S_u - S_y)}{S_u - S_n}$

Safety Factor: $SF = \frac{\sigma_{a,limit}}{\sigma_{a,actual}}$